Revisiting hadron production at SIS energies using new HADES data *

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We present preliminary results on the production of hadrons with strangeness content (K^+, K^-, K^0_s, Λ and ϕ) in Au+Au collisions. At the measured center of mass energy of $\sqrt{s}$ = 2.4 GeV all hadrons carrying strangeness are produced below their free nucleon-nucleon threshold. While the K^-/K^+ ratio nicely fits the trend observed at higher energies, we find a strong rise of the ϕ/K^- ratio.

The data taking took place in April/May 2012. The readout was started with a multiplicity trigger, running with an average rate of 8 kHz during the spills. The total data sample corresponds to 7.3x10^9 events. Reconstructed tracks pass a track selection based on several quality parameters delivered by a newly developed high density tracking algorithm. Afterwards, hadrons are identified using the time-of-flight measurement.

In order to minimize systematic errors due to efficiency corrections and extrapolations in rapidity, we build ratios of the corrected yields at mid-rapidity for various hadron species which feature a comparable width in rapidity. The resulting K^-/K^+ ratio can be directly compared to the previously obtained systematics at similar energy, without correcting for the different centrality selections of the various experiments, as both kaons experience a similar A_{part} dependence [1]. The measured ratio K^-/K^+ fits into the trend observed at slightly higher energies and extrapolated down to the beam energy of 1.23 A GeV.

An interesting observable is the ϕ/K^- ratio: It shows a flat trend at high energies, and is experimentally observed to rise towards lower energies [2]. This rise can be reproduced in the framework of the statistical model, if the suppression of strangeness is handled by introducing a strangeness correlation radius R_c within which strangeness has to be exactly conserved [3]. It is important to realize that, as the ϕ conserves strangeness by definition, it is not suppressed by the strangeness correlation parameter in contrast to the other particles containing strange quarks.

We simultaneously fit the π^-/p, K^0_s/Λ, K^-/K^+ and the ϕ/K^- ratio using the freely available statistical model THERMUS [4]. Similar as for our fit to the Ar+KCl data sample [5] we constrain the charge chemical potential μ_Q using the ratio of the baryon and charge numbers of the collision system, conserve the baryon number on average via the chemical potential μ_b and calculate strangeness canonically by introducing the additional sub volume defined by R_c. As we are restricted to ratios we fix the radius of the fireball R arbitrarily to 3 fm. In this way we find the chemical freeze-out at a temperature of $T_{chem} = (47 \pm 5)$ MeV and at a baryochemical potential of $\mu_b = (799 \pm 22)$ MeV. The ratio R_c/R is determined to 0.3 ± 0.2 while the χ^2/d.o.f. of the fit corresponds to 1.2. We note that our freeze-out point fits remarkably well to the result obtained in [6] for a similar system but restricted to fewer identified particles. Also R_c/R agrees within errors with the value obtained in our Ar+KCl fit of 0.5 ± 0.3. Going from the medium-sized Ar+KCl system (measured at 1.76 AGeV) to the heavy Au+Au system the ϕ/K^- ratio rises strongly. This effect is reproduced by statistical model calculations, using the above discussed parameters (especially R_c).

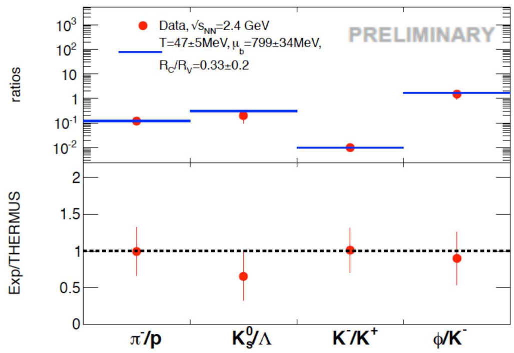

Figure 1: Comparison of hadron yields ratios of model and data, together with values obtained for the free parameters of the statistical model fit, see text for details.

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